Alberta
ENVIRONMENT
Environmental Evaluation Services
Land Conservation and
Reclamation Council

Office of J.M. King, Chairman

#RRTAC 85-2

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1 Apr 1985

Honorable Fred D. Bradley
Minister of Environment
132 Legislature Building
Edmonton, Alberta
T5K 2B6

Dear Sir:

Enclosed is the "Reclamation Research Annual Report - 1984".

This Program Status Report was prepared by the Reclamation Research Technical Advisory Committee under the direction of the Land Conservation & Reclamation Council.

Yours truly

J.M. King

PFZ:md

Encl.

RECLAMATION RESEARCH

ANNUAL REPORT

1984

REPORT # RRTAC 85-2

Prepared

by

Paul F. Ziemkiewicz, Chairman

Reclamation Research Technical Advisory Committee

of the

Alberta Land Conservation & Reclamation Council

31 March 1985

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INTRODUCTION

The regulation of surface disturbances in Alberta is the responsibility of the Land Conservation and Reclamation Council. The Council executive consists of a chairman from the Department of the Environment and two deputy chairmen from the Department of Energy and Natural Resources. Among other functions, the Council oversees programs for reclamation of abandoned disturbances and reclamation research. The reclamation research program was established to identify the most efficient methods for achieving acceptable reclamation. Funds for implementing both the operational and research programs are drawn from Alberta's Heritage Savings Trust Fund.

To assist in technical matters related to the development and administration of the research program the Council appointed the Reclamation Research Technical Advisory Committee (RRTAC). The Committee first met in March, 1978 and consists of eight members representing the Alberta Departments of Agriculture, Energy and Natural Resources, Environment and the Alberta Research Council. The Committee meets regularly to up-date research priorities, review solicited and unsolicited research proposals, arrange workshops and otherwise act as a referral and coordinating body for reclamation research.

Our Reclamation Research Projects are trials for new technologies and are reviewed and rated on their adherence to priorities, likelihood of success and competence of researchers. Throughout the review process the key question is: "Would this technology make reclamation in Alberta a more efficient process?"

Research projects results are made available through Publication and Distribution of Reclamation Research Reports. The following section is a listing of available reports.

Additional information on the Reclamation Research Program may be obtained by contacting:

Dr. Paul F. Ziemkiewicz, Chairman
Reclamation Research Technical Advisory Committee
2nd Floor, Pacific Plaza
10909 Jasper Avenue
EDMONTON, Alberta T5J 3M8

RECLAMATION RESEARCH REPORTS

			REPORT NO.
*1.	TITLE:	The Role of Organic Compounds in Salinization of Plains Coal Mining Sites.	RRTAC 80-3
	AUTHOR(S):	N.S.C. Cameron et al.	
	DESCRIPTION:	This is a literature review of the chemistry of sodic mine spoil and the changes expected to occur in groundwater. 46 p.	
*2.	TITLE:	Proceedings: Workshop on Reconstruction of Forest Soils in Reclamation.	RRTAC 80-4
	AUTHOR(S):	P.F. Ziemkiewicz, S.K. Takyi, H.F. Regier	
	DESCRIPTION:	Experts in the Field of Forestry and Forest Soils Report on Research relevant to Forest Soil Reconstruction and discuss the most effective means of restoring forestry capability of mined lands. 160 p.	
*3.	TITLE:	Manual of Plant Species Suitability for Reclamation in Alberta, 2 Vols.	RRTAC 80-5
	AUTHOR(S):	L.E. Watson, R.W. Parker, P.F. Polster	
	DESCRIPTION:	Forty-three grass, fourteen forb and thirty-four shrub and tree species are assessed in terms of their fitness for use in Reclamation. Range Maps, Growth Habit, Propagation, Tolerances and Availability. 541 p.	
*4	TITLE:	1980 Survey of Reclamation Activities in Alberta	RRTAC 81-2
	AUTHOR(S):	D.G. Walker, R.L. Rothwell	
	DESCRIPTION:	This survey is an update of the original Report conducted in 1976 on Reclamation Activities in Alberta, includes Research and Operational Reclamation, locations, personnel etc. 76 p.	

Available from: Publication Services
Queen's Printer
11510 Kingsway Avenue
EDMONTON, Alberta T5G 2Y5

* A $5.00 fee is charged for handling and postage.
** A $20.00 fee is charged for handling and postage.

Please make cheque payable to: "Provincial Treasurer of Alberta"

		RECLAMATION RESEARCH REPORTS Cont'd.	REPORT NO.
*5.	TITLE:	Proceedings: Workshop on Coal Ash and Reclamation.	RRTAC 81-3
	AUTHOR(S):	P.F. Ziemkiewicz, R. Stien, R. Leitch, G. Lutwick	
	DESCRIPTION:	Presents nine technical papers on the Chemical, Physical and Engineering Properties of Alberta Fly and Bottom Ashes, Revegetation of Ash Disposal Sites and Use of Ash as a Soil Amendment Workshop discussions and summaries are also included.	
*6.	TITLE:	Land Surface Reclamation: An International Bibliography. 2 Vols.	RRTAC 82-1
	AUTHOR(S):	H.P. Sims, C.B. Powter	
	DESCRIPTION:	Literature pertinent to Reclamation in Alberta is listed in Vol. 1 and is also on the University of Alberta Computing System. The Keyword Index and Computer Access Manual comprises Vol. 2. 292 p.	
*7.	TITLE:	A Bibliography of Baseline Studies in Alberta: Soils Geology, Hydrology and Groundwater.	RRTAC 82-2
	AUTHOR(S):	C.B. Powter, H.P. Sims	
	DESCRIPTION:	This Bibliography provides baseline information for persons involved in Reclamation Research or in the Preparation of Environmental Impact Assessments. Materials, up to date as of Dec. 1981 are available from the Alberta Environmental Library. 97 p.	
*8	TITLE:	Soil Reconstruction Design for Reclamation of Oil Sand Tailings.	RRTAC 83-1
	AUTHOR(S):	Monenco Consultants Ltd.	
	DESCRIPTION:	Volumes of Peat and Clay required to amend Oil Sand Solid Tailings were estimated based on existing literature. Separate soil prescriptions were made for Spruce, Jack Pine and Herbaceous cover types. The estimates form the basis of recently initiated field trials. 185 p.	

RECLAMATION RESEARCH REPORTS Cont'd. **REPORT NO.**

*9. TITLE: Evaluation of Pipeline Reclamation Practices on Agricultural Lands in Alberta. RRTAC 83-3

AUTHOR(S): Hardy Associates (1978) Ltd.

DESCRIPTION: Available information on Pipeline Reclamation practices was reviewed. A field survey was then conducted to determine the effects of pipe size, age, soil type construction method etc. on resulting crop reproduction. 205 p.

*10. TITLE: Proceedings: Effects of Coal Mining on Eastern Slopes Hydrology RRTAC 83-4

AUTHOR(S): P.F. Ziemkiewicz

DESCRIPTION: Technical Papers are presented dealing with the impacts of Mining on Mountain Watersheds, their flow characteristics and resulting water quality. Mitigative measures and Research priorities were also discussed. 123 p.

*11. TITLE: Woody Plant Establishment and Management for Oil Sands Mine Reclamation. RRTAC 83-5

AUTHOR(S): Techman Engineering Ltd.

DESCRIPTION: This is a review and analysis of information on planting stock quality, rearing site preparation, planting and procedures necessary to ensuring survival of trees and shrubs in oil sand reclamation. 124 p.

?. TITLE: Land Surface Reclamation: A Review of International Literature. 2 Vols. RRTAC 84-1

AUTHOR(S): H.P. Sims, C.B. Powter, J.A. Campbell

DESCRIPTION: Nearly all topics of interest to Reclamation includes Mining Methods to Soil Amendments, Revegetation, Propagation and Toxic Materials are reviewed in light of the International Literature. 1549 p.

		RECLAMATION RESEARCH REPORTS Cont'd.	**REPORT NO.**
*13.	TITLE:	Propagation Study: Use of Trees and Shrubs for Oil Sand Reclamation	RRTAC 84-2
	AUTHOR(S):	Techman Engineering Ltd.	
	DESCRIPTION:	This Report evaluates and summarizes all available published and unpublished information on large-scale propagation methods for shrubs and trees to be used in Oil Sand Reclamation.	
*14.	TITLE:	Soil Microbiology in Land Reclamation. 2 Vols.	RRTAC 84-4
	AUTHOR(S):	D. Parkinson, R.M. Danielson, C. Griffiths, S. Visser and J.C. Zak	
	DESCRIPTION:	This is a collection of five Reports dealing with Reestablishment of Fungal Decomposers and Mycorrhizal Symbionts in various amended spoil types. 676 p.	
*15.	TITLE:	Proceedings: Revegetation Methods for Alberta's Mountains and Foothills	RRTAC 85-1
	AUTHOR(S):	P.F. Ziemkiewicz	
	DESCRIPTION:	Results of long-term experiments and field experience on Species Selection, Fertilization, Reforestation, Topsoiling Shrub Propagation and Establishment are presented.	
*16.	TITLE:	Reclamation Research Annual Report - 1984	RRTAC 85-2
	AUTHOR(S):	P.F. Ziemkiewicz	
	DESCRIPTION:	This Report details the Reclamation Research Program indicating priorities, descriptions of each Research Project, researchers, results and expenditures. 29 p.	

MINING AND RECLAMATION IN ALBERTA

Most of Alberta's industrial activity occurs in three major biophysical regions: The Plains, where most of the Province's agricultural land is located, the Mountains and Foothills where recreation, forestry, wildlife and watershed values are predominant, and Northeast Alberta, where wildlife and forestry values exist.

Coinciding with these regions are three major disturbance types:

1) **Plains**: Coal mines operated in conjunction with electrical generating plants,

2) **Mountains and Foothills**: Metallurgical coal mines and high quality thermal coal for export, and

3) **Northeast Alberta**: Oil sand mining and extraction facilities.

While it is expected that research results will often have province-wide application, the division of the program among the three biophysical regions has proven helpful in identifying priorities and directions for the research program.

THE RESEARCH PROGRAM

Following is a summary of research projects as of March, 1985. Project titles are followed by the names of the principal investigators and their affiliation.

Upon project completion a final report is submitted. Some final reports are published intact as RRTAC Reports and released to the public. Others are held pending their inclusion in comprehensive RRTAC Reports.

1. PLAINS

Reclamation Objectives

To return crop land to pre-mining levels of productivity. Productivity is taken to include both agricultural and hydrologic capabilities.

The Problem

The plains coal seams are usually overlain by bedrocks which contain a high proportion of swelling clays. When exposed to the elements the bedrock shales and sandstones break down into a material that is sticky when wet and very hard when dry. This severely hinders plant growth and agricultural operations. Above the bedrock lie glacial deposits which are usually free of the most adverse properties of the bedrock though they lack the plant nutrients and organic matter characteristic of the overlying topsoil.

Rebuilding a soil profile is one of the major problems in cropland reclamation in Alberta. A soil must be built on levelled overburden which will be as productive as the original soil. Existing evidence indicates that placing topsoil and a buffering material over the spoil is the most efficient method for achieving this goal (Figure 1). However, we do not know how much capping material is needed. Also, where topsoils or subsoils are in short supply other amendments may be useful in soil building. In addition to soil reconstruction certain agricultural practices like green manuring and legume cropping may help rebuild the soil.

In many plains areas the coal seams are the major source of domestic water. What will happen when the coal is removed and overburden fills the mined-out pit? The behavior of the post-mining groundwater system will affect water users and could influence future agricultural potential. However, prior to the

Reclamation Research Program little was known about the effects of surface mining on groundwater in Alberta.

Mining on Agricultural Land

Cropland is surface mined in two major zones in Alberta: **The Ardley Zone** running southeast from Mayerthorpe to Red Deer and the **Horseshoe Canyon Zone** which runs parallel and to the east from Barrhead through Camrose to Drumheller. The Ardley Zone is surface mined near Lake Wabamun to provide coal to the Wabamun and Sundance power plants. Two additional power plants, Keephills and Genessee are presently under construction and will extend mining southward to the town of Genessee. The Horseshoe Canyon Zone is mined on either side of the Battle River between Forestburg and Halkirk. These mines supply the Battle River Generating Station. Another power plant and mine are being developed to the south at Sheerness (Figure 2).

Approach

Mining in the Ardley and Horseshoe Canyon Coal Zones involves two different sets of soils, overburden and climate. Also, soil reconstruction and groundwater cannot be studied in isolation. For example, if after mining a saline watertable re-establishes within a foot of the soil surface the topsoil, regardless of it's original quality, will quickly become unsuitable for crops. So in both the Ardley and Horseshoe Canyon Zones we are identifying the best methods of reconstructing soils and at the same time we are studying what happens to the groundwater after mining. Table I summarizes our priorities and research activities in the Plains.

A) RECLAMATION OF COAL MINED LAND

Plains Coal Reclamation Research Program

The Plains Coal Reclamation Research Program (PCRRP) has been designed by the Provincial Government and members of the Coal Industry to answer questions relating to groundwater and soil reconstruction in both of our Plains Coal Mining Zones. Two main projects have been established:

1) **The Plains Soil Reconstruction Project** will tell us how to rebuild agricultural soils after mining and

2) **The Plains Hydrology and Reclamation Project** will describe what happens to groundwater during mining and after reclamation and how to rebuild the landscape to maximize the agricultural potential.

By combining the results of these experiments we will develop a picture of how mined landscapes work and how they can be designed to ensure the return of their original values.

These projects are installed both at the Highvale and Battle River mining areas. Both are designed for five years of intensive study with the possibility for further monitoring beyond that period.

The program has been jointly designed and managed by Provincial Government and Coal Industry personnel. The projects are also funded by both Industry and Government. For example, Alberta Power Ltd., Luscar Ltd., Manalta Coal Ltd. and TransAlta Utilities Ltd. constructed the Test Plots at Battle River and Highvale while research and maintenance activities for the Soil Reconstruction and Hydrology Programs are supported by the Government from the Heritage Savings Trust Fund.

1. **Battle River Soil Reconstruction Project (82-5-LES)**
   L.A. Leskiw, Pedology Consultants Ltd

2. Highvale Soil Reconstruction Project (82-13-SCH)
L.A. Panek, Montreal Engineering Co. Ltd.

Grain and forage yields are being evaluated on a series of soil reconstruction plots at the Battle River and Highvale Mining Areas. Treatments include: depth of subsoil (0 to 3m thicknesses) over sodic spoil, use of bottom ash as an impediment to upward salt migration, use of coal ash and gpysum as soil amendments and reconstruction of solonetzic topsoils using different horizons and mixtures. Lateral salt migration through reconstructed soils over spoil slopes is also being studied. The project began in 1979 at Battle River and construction was completed at Highvale in 1982. (See Figures 3, 4)

Status: Cropping and Soil Sampling began at Battle River in 1982 and we now have two crop years of data. The first crop was grown at Highvale in 1983. Each site will be studied intensively for at least five years.

3. Plains Hydrology and Reclamation Project (79-2-MOR)
S.R. Moran, Alberta Research Council

This study examines the impacts of surface mining on the regional groundwater, geology and soils. The main objectives include the identification of: 1) changes in groundwater quality and quantity after mining, 2) sources and release rates of groundwater contaminants (mainly salts), 3) changes in distribution of groundwater after mining (will the groundwater carry salts to the surface, will the watertable drop or will it re-establish at premining levels) and 4) surface stability after mining (subsidence, piping).

Critical groundwater and geologic parameters will be identified which should allow us to predict the "reclaimability" of a site prior to mining. This project began in 1979 and, like the Plains Soil Reconstruction Project it is duplicated at the Battle River and Highvale Sites.

Status: **Battle River** monitoring equipment is in place and the detailed soil survey has been completed. Three years of hydrologic data have been collected north of the Battle River, and two years on the south side.

Highvale - Installation and monitoring began in 1982. Each site will be intensively monitored for at least five years.

Results to date:

The project objective is subdivided into 9 subobjectives, which provide the basis for the following summary of project status

a. **Salt production and migration in reclaimed landscapes**

The evaluation of long-term potential for salinization of reclaimed soils has involved (1) studies of the production of salt and (2) the transport of salt by groundwater. One of the major concerns at the initiation of the study was that weathering of overburden materials, especially minerals containing sulphur in a reduced form, would lead to the long-term production of sulfate salts. Research has established that, although considerable new salt can be released as a result of weathering of overburden materials, the processes are rapid and essentially complete soon after final regrading of the spoil surface.

Although large amounts of salt are available from this weathering process and from salts already present in the overburden, especially in the lower part of the original soil zone, the release of this salt is limited by physical factors such as access to water and hydraulic conductivity of the spoil and by chemical saturation constraints. Regardless of the source of the salt, groundwater in mine spoil is saturated with respect to calcite, dolomite, and gypsum. The factor that appears most critical in limiting salinity of spoil water is the availability of calcium over and above the level that can be consumed by ion exchange reactions.

Thus far, the researchers have found little evidence of salt being transported to the spoil surface by groundwater discharge, or of perched water table formation at the replaced soil-spoil interface. The main mechanisms of potential soil salinization appear to be upward transport of water and salt by capillary rise from the water table where it is sufficiently close to the surface.

b. **Landscape**

Study of potential selective placement of overburden was predicated on the assumption that significant differences would be found between overburden materials in terms of their susceptibility to weathering release of high levels of salt. Although the salt production potential of overburden material has been found to vary by a factor of more than 10, even at the low end of the range, sufficient salt is available to produce severely degraded

chemical quality in the groundwater that resaturates the spoil. For this reason, the research has focused more strongly on using topographic configuration to control post-mining hydrology and thereby control the impact of the degraded groundwater on the landscape.

Progress toward the second aspect of this subobjective has focused on the role of ponds in the post-mining landscape. The researchers have shown that ponds play a major role in rapid resaturation of spoil and in maintenance of water levels in spoil that in places are considerably above the level in adjacent unmined areas.

c. **Post-reclamation water supply**

Study of the Battle River and Highvale sites has progressed to the stage that potential post-mining water supply options have been identified and evaluated. In addition, a generalized procedure for making such an assessment at any new mine site will have been proposed by the end of the year.

d. **Agricultural productivity and capability of reclaimed landscapes**

A rating system was developed on a basis similar to that of the Canada Land Inventory Soil Capability for Agriculture system, and will allow for the placement of "reconstructed" soil mapping units into appropriate rating classes and subclasses based on climate, landscape and soil factors. Further work is required to evaluate the relationship between

the capability classes so defined and the agricultural productivity of the reclaimed landscape.

e. **Surface subsidence in reclaimed landscapes**

Settlement of the surface of reclaimed landscapes has been shown to be a significant process affecting the utilization of the landscapes for agriculture. Resaturation of the spoil has been shown to be a significant factor in producing compaction and therefore settlement. Depressions produced by this type of settlement have the potential to alter post-reclamation drainage patterns and increase infiltration and recharge by increasing surface retention of water. Further study is needed to assess the extent of this phenomenon.

f. **Potential degradation of groundwater and surface water resources**

Evaluation of hydrologic impacts of salinized groundwater from mine spoil has focused on potential degradation of surface water and groundwater supplies. The data show that the potential for contamination of such surface water bodies as the Battle River and Paintearth Creek is very low and no further work is believed needed. However, signficantly degraded water was found migrating laterally from one reclaimed area into adjacent unmined aquifers.

g. **Infiltration and groundwater recharge characteristics of reclaimed landscapes**

Study of infiltration and groundwater recharge has

shown that processes in reclaimed landscapes are similar to those in unmined landscapes. The major difference appears to relate to deeper penetration of infiltrating water in reclaimed landscapes as a consequence of removal of natural stratification. All study sites have been resaturated and an apparently stable groundwater regime has been established far quicker than should be the case given the rate at which recharge processes are currently operating. It seems that the combination of fracturing of the spoil mass and ponding of water in low areas allows for extremely rapid influx of water into the spoil mass at rates perhaps 10 to 100 times as fast as in the unmined landscape. This has important implications for many aspects of reclaimed landscape stabilization, ranging from surface subsidence, to cessation of overburden weathering, to the establishment of a stable post-mining groundwater regime in the spoil.

4. Physical and Chemical changes in Stockpiled Topsoil (79-26-FUJ)
J. Fujikawa, Technical Development Branch, Alberta Environment

A topsoil stockpile near Bow City, Alberta, had been monitored along with undisturbed topsoil to determine whether adverse changes occur during storage. Ultimately this line of research will indicate how long topsoil can be stored before deterioration occurs.

Status: Completed

Results: Final Report 79-26-FUJ. No significant adverse changes have been measured during three years of monitoring.

5. Contribution of Groundwater Organic Compounds to Salinization In Plains Surface Mining (79-22-HOD, 79-27-HOD)
G.W. Hodgson, University of Calgary

These projects examined the organic chemistry and microbiology of mine spoil weathering and were instituted to complement the inorganic chemistry approach taken in the Plains Hydrology Reclamation Project.

Status: Completed
Results: Final Report 79-27-HOD
Report # RRTAC 80-3

B) PIPELINES

6. Evaluation of Pipeline Reclamation Practices on Agricultural Land (81-1-HAS)
W.J. Hastie, Hardy Associates (1978) Ltd

This study addressed the effects of construction and reclamation of three pipeline sizes: 56", 36" and 10". A description of the major types of pipeline construction and reclamation techniques was prepared and their difference relative to surface disturbance noted for various soil zones, types, and agricultural land uses.

Status: Completed
Results: Report # RRTAC 83-3

C) FLY & BOTTOM ASH DISPOSAL

Three studies were conducted to characterize Alberta Coal Ashes and to assess their effects on soils and crops.

7. Chemical Characterization of Bottom Ash and Fly Ash From Four Alberta Power Stations (78-2-MCC)
D. McCoy, Technical Development Branch, Alberta Environment

8. Plant Nutrient-Agronomic Potential of Coal Ash (78-20-MCC)
D. McCoy, Technical Development Branch, Alberta Environment

9. Physical and Chemical Characterization of Fly Ash (78-5-P/R)
D. Pluth, J. Robertson, Soils Dept., University of Alberta

Ash samples were collected over a period of time and analysed to determine if fly and bottom ash chemistry varied among various coal seams and power plants, and whether ash from a given source varies significantly through time. Various rates of fly ash and bottom ash were mixed with two soils and a sodic spoil to determine whether ash addition can enhance growth of barley and alfalfa. Fly Ash from five sources around Alberta were surveyed for physical and chemical properties. Plant toxicities were evaluated in greenhouse studies.

Status: Completed
Results: Report # RRTAC 81-3

10. Use of Bottom Ash as an Amendment to Sodic Spoil (83-4-LAN)
S. Landsburg, Alberta Environment

Prior to the current practice of soil salvage and replacement surface mined land in the Plains generally reverted to waste land. This was particularly true where sodic overburden was encountered. Reclamation of these orphaned areas in the absence of suitable soil requires amendment of the sodic spoil surface. Perhaps the most promising amendment appears to be bottom ash from the nearby

power plants. Earlier research indicated that this waste product possesses the ability to significantly improve sodic spoil. This project will identify, through field testing, which ash amendment rates and incorporation methods are most effective in developing at least minimal productive potential in orphaned sodic spoil.

Status: Ongoing, plots constructed in 1982, cropped and monitored since.

11. MOUNTAINS AND FOOTHILLS

Reclamation Objectives

1) Control of erosion on a wide variety of disturbances including coal mines, mineral exploration sites, coal ash pits and oil and gas well sites.

2) Return of forested lands to previous levels of productivity.

3) Return of wildlife range to previous levels of productivity.

The Problem

Reclamationists in the mountains and foothills face a wide variety of conditions. While some foothill sites are characterized by subdued terrain and moderate climate other sites, particularly in the mountains, present steep slopes, rocky spoil and a short growing season. On these problem sites summer droughts, chinook winds, erodible slopes and nutrient-poor soils are common.

On lower elevation foothill sites reclamation is expected to yield forests with commercial potential while on the higher elevation mountain sites erosion control, development of wildlife habitat and recreation potential are the reclamation objectives.

Reclaimed land in the mountains and foothills will not be as intensively managed as reclaimed agricultural lands would be. Also, topsoils and subsoil layers tend to be thin and difficult to handle selectively. They nontheless are a valuable source of plant nutrients. So while some mixing of horizons is inevitable how much is acceptable? How thick should the replaced soil layer be? Other sites simply have no salvageable topsoil and Reclamation must prepare the site so that a plant-soil system will develop which will perform its land use expectations without indefinite fertilization.

Table 2 indicates our priorities and program summary in the Mountains and Foothills.

A) LANDSCAPE DESIGN

One of the most important aspects of Reclamation in the Mountains and Foothills is creation of stable reclaimable landscapes. This includes dump design (optimal slope angles and lengths, terracing) and pit backfilling. Another critical aspect of landscape design involves the creation of new water-sheds. These must be designed to control water flows and siltation of surrounding waters.

1. Mountain and Foothill Dump Design (82-14-CHO)

R.G. Chopiuk, Coal Mining Research Center

In Phase 1 resloped overburden dumps in Alberta and British Columbia were surveyed to identify practical construction and resloping strategies. It was found that many though not all dumps were graded to shallower slopes (22-24°) than had been designed (27°). Operator and machine limitations were cited.

In Phase 11 a number of slopes were instrumented to identify

the volumes of erosional loss due to various slope angles, lengths, crossberms and topsoiling.

Status: Ongoing

2. Analysis of Settling Pond Design and Alternative Technologies (84-12-MON)
A.H. Somani, Monenco Consultants Ltd.

Methods for design and construction of settling ponds were evaluated with respect to Mountain and Foothill conditions. Also, alternatives to settling ponds were assessed.

Status: Completed
Results: FR/84-12-MON

B) SOIL RECONSTRUCTION

Soil Reconstruction in the Mountains and Foothills involves making the best use of limited soil materials. The objective is to improve the Root Zone over Rocky and Nutrient-Poor Spoils. At Grande Cache coal ash disposal sites must be revegetated with implications for building a soil on the ash surface.

Of particular interest is the reinstatement of commercial forest capability on mined land. Three test plots have been established in the Foothills by Luscar Ltd., Union Oil of Canada Ltd. and Crows Nest Resources Ltd. which compare various thicknesses and blends of soil materials for commercial tree growth. These projects were developed in consultation with RRTAC and are supported entirely by company funds.

In 1984 The Coal Association of Canada and RRTAC initiated the jointly-funded Mountain and Foothills Reclamation Research

Program (MFRRP). The program's initial objectives focus on Water Management, Soil Reconstruction, Reforestation and Wildlife Habitat Development. Projects 2, 3, 17 and 18 represent the first year's activities in MFRRP.

Several projects conducted by the Reforestation & Reclamation Branch of the Alberta Forest Service have met their initial objectives. The results are published in Report # RRTAC 85-1. These plots remain available should additional monitoring intervals be required.

3. Soil Reconstruction in Mountain and Foothill Coal Mining (84-23-PED)
L. Knapik, Pedocan Land Evaluation Ltd.

This review assembled available information to facilitate operational reclamation decisions to provide for tree growth (forestry use), shrub growth (wildlife habitat) and herbaceous cover (erosion control). This review also identified information gaps and recommended needed research.

4. Revegetation of Ash Disposal Sites, .Grande Cache (79-1-MAC)
T.M. Macyk, Alberta Research Council

This project identified the thickness of capping material over coal ash required to support an erosion-controlling cover crop. This was a co-operative project with McIntyre Mines Ltd.

Status: Completed

Results: Final Report 79-1-MAC. With thirty cm of capping soil good plant growth and cover were observed. Increasing depths of capping soil gave no increase in yields.

C) REVEGETATION

Reclamation programs may have several objectives in the Mountains and Foothills including development of forestry capability, wildlife habitat and watershed values. Our objective is to develop revegetation methods which will meet objectives without long-term maintenance. Within the revegetation problem area priorities have been identified for herbaceous cover (species selection, erosion control, fertilization, nutrients) and for shrub and tree cover (propagation, establishment).

SPECIES SELECTION

5. Selection of Native Grasses for Reclamation (79-7-WEI)
R. Hermesh, Alberta Environmental Center

Many alpine and subalpine sites are difficult to reclaim simply because commercially available grasses and legumes either cannot survive or reproduce in the short growing season. This study is selecting lines of native grasses which are known to invade disturbances in the subalpine and alpine. Selections are made on the basis of commercial potential and fitness for reclamation.

Status: Ongoing

Results: Three lines of Agropyron species are presently undergoing testing for licencing application with the Canadian Department of Agriculture.

6. Native Grasses for Reclamation: Selected Line Adaptability Trials (79-23-WEI)
P.F. Ziemkiewicz, Alberta Energy and Natural Resources

By early 1979 the above study had produced nine selected

lines of native grass species. To ensure that the selected lines had not lost their tolerance to high-elevation conditions in the process of development, a series of test plots was established: 1) to evaluate their fitness to subalpine and alpine conditions, 2) to compare their performance against selected agronomic grasses and 3) to evaluate their respective fertilizer requirements.

Status: Completed

Results: Report # RRTAC 80-1, Report # RRTAC 85-1

7. Evaluation of Native-Agronomic Grass/Legume Mixes for Reclamation of Subalpine Disturbances (78-18-RUS)
H. Tomm, Alberta Forest Service

Certain agronomic grasses and legumes are known to quickly establish an erosion-controlling cover while native grasses generally grow more slowly. This experiment tests which of several native/agronomic seed mixes provides the best combination of erosion-control and long-term stability.

Status: Completed

Results: Report # RRTAC 85-1

8. Survey of Alberta Forest Service Native Grass Trials (82-12-TOM)
M. Mihajlovich

Between 1975 and 1977 a number of Test Plots were established in the Mountains and Foothills from Alpine to Boreal Forest conditions. Native Grass, Tree and Shrub container plantings were tested as well as various topsoiling treatments. Other treatments included island transplants and various agronomic legumes. This study was undertaken in 1982 to: 1) Document

the location of the Plots and 2) gather and synthesize all available information.

Status: Completed
Results: Report # RRTAC 85-1

EROSION CONTROL

9. Methods for Establishing Grass Cover on Unamended Coal Spoil (80-11-TAK, 79-17-TAK)
S.K. Takyi, Alberta Forest Service

This study compares different seeding methods for native grass mixes (hydroseeding, broadcasting and raking, simulated drilling). Also various erosion-controlling mats, mulches and contouring treatments are evaluated.

Status: Completed
Results: Report # RRTAC 85-1

10. Survey of Alberta Forest Service Reclamation Sites (78-1-LAR)
G. LaRoi, University of Alberta, Forest Science Department

Reclamation roads and drilling sites were surveyed in 1978 to assess revegetation success 4 to 7 years after treatment. Permanent sampling plots were established which may be reassessed in the future to better understand plant succession on reclaimed sites.

Status: Completed
Results: Final Report 78-1-LAR

FERTILIZATION, NUTRIENTS

11. Factors which Accelerate Development of Stable Nutrient Cycles (82-11-Z/T)

P.F. Ziemkiewicz, S.K. Takyi,
Alberta Energy & Natural Resources

The effects of topsoiling, Species Selection (Native vs Agronomic, Grass vs Legume) and Maintenance Fertilizer Regime are evaluated on a Subalpine Coal Mine with regard to plant development, distribution, uptake and cycling of nutrients.

Status: Ongoing

12. Survey to Determine the Occurrence of Microbial N-fixing Root Sheaths (79-8-L/R)

M.J. Rowell, Norwest Soils Ltd.

Preliminary work suggested that root sheaths may be a significant source of N-fixation for grasses growing in nutrient-poor soils. This survey was commissioned to look for root sheath occurrence on reclaimed and undisturbed areas. Correlations were made between plant vigor and root sheath occurrence. N-fixing rhizosheaths were found on grasses growing on disturbed sites more commonly than on undisturbed sites. Future work may involve isolation and identification of the N-fixing organisms. When available, the resulting inocula would be tested under field conditions to determine whether they have value as a reclamation treatment.

Status: Completed
Results: Final Report 78-8-L/R

13. Uptake of Nitrogen by Native Grasses (78-3-M/P)
D. Paton, University of Alberta

It is often assumed that native grasses require less nutrient than their agronomic counterparts. This study compared the nitrogen uptake rates of native and agronomic grasses to learn more about their nutrient requirements.

Status: Completed
Results: Final Report 78-3-M/P

The above projects have developed improved reclamation grasses, identified successful seed mixes, fertilization and erosion control practices Future work will emphasize propagation and establishment of woody species.

TREE & SHRUB PROPAGATION

14. Native Shrub Seed Propagation Testing Project (80-16-KIN)
P. King, Alberta Forest Service

Methods for collecting, handling and treating seed of native shrub species with potential for reclamation will be evaluated to maximize propagation success.

Status: Completed
Results: Report # RRTAC 85-1

15. Factors Affecting Germination of Buffaloberry (82-1-K/H)
C. Keating, University of Alberta, Forestry Department

Buffaloberry (Shepherdia canadensis) is a valuable shrub

for Reclamation, but it is difficult to propagate. This Study investigated methods for enhancing germination of Buffaloberry seed so that stock may be produced in large quantities for Mine Reclamation.

Status: Completed
Results: Final Report 81-1-K/H

TREE & SHRUB ESTABLISHMENT

16. Optimization of Erosion Control and Reforestation Potential of Reclaimed Areas (79-16-MIH)
P. King, Alberta Forest Service

This study will identify the level of grass/legume cover which will prevent erosion yet permit tree seedling growth. This study will also identify methods for predicting the optimal levels of herbaceous cover.

Status: Ongoing
Results: Report # RRTAC 85-1

17. Growth Performance of Commercial Timber Species in Reclamation (84-28-DEM)
W.R. Dempster and Associates Ltd.

The purpose of this study was to review and report, from available literature, growth performance data that could be used to develop standards expected of commercial timber species for reclaimed lands in the Eastern Slopes of Alberta.

Study Parameters included:

1. Rates of juvenile growth, and appropriate measurement

techniques and timing, required to provide reasonable assurance of successful reclamation;

2. The impact of site and cultural factors on growth performance, and the extent to which growth can be predicted from these factors;

3. Recommendations for the development of growth performance standards or guidelines including growth rate expectations, assessment methodology, the length of time required to assess performance, and the extent and acceptability of management inputs;

4. Further research required to assist in the formation of growth standards and guidelines.

Status: Completed
Results: FR/84-28-DEM

18. Reclamation for Wildlife Habitat in The Mountains and Foothills of Alberta (84-18-LGL)
J.E. Green, LGL Ltd.

This Study addressed: the synthesis of current information on habitat requirements of major wildlife species in the Mountains and Foothills of Alberta, an evaluation and collation of information on reclamation procedures for wildlife habitat, the applicability of these methods to Alberta, and the development of criteria for the assessment of wildlife habitat reclamation procedures for certification purposes.

Status: Completed
Results: FR/84-18-LGL

111. NORTHEAST ALBERTA

Reclamation Objectives

1) To develop techniques whereby a self-sustaining, erosion-free cover can be established on oil sand tailings pond dykes.

2) To return tailings sand storage and overburden dumps to productive forest.

The Problem

Northeast Alberta contains all of Canada's surface-mineable oil sands. Extraction of this valuable petroleum resource presents several problems for reclamation. By far the greatest problem lies with the tailings disposal systems currently employed.

At the end of its 25 year life a typical oil sand plant producing 19 900 cubic meters per day (125 000 barrels per day) of synthetic crude oil will require a 22 to 31 square kilometer (8.5 to 12 square miles) tailing pond. The liquid contents of the pond will consist primarily of 360 million cubic meters of sludge. The sludge will remain in a liquid state indefinitely and will be impounded behind dykes built of tailings sand. Dyke heights will reach from 55 to 100 meters above ground level. Erosion protection will be provided by a cover of grasses, legumes and shrubs. Because the tailings sand is devoid of nutrients and drains rapidly, amending materials (Muskeg, certain mineral overburdens) will be added to begin development of a soil.

Pits left after mining will be filled with tailings sand and overburden dumps will be constructed. These sites will also be reclaimed to a designated land use. Soil reconstruction and woody plant establishment in particular need further research.

Approach

As in the mountains and Foothills, proper reclamation in Northeast Alberta will produce landform and plant community combinations which will fulfill their land use requirements without indefinite maintenance.

In order to pool resources and avoid duplication of effort, RRTAC and the industry's Oil Sands Environmental Study Group (OSESG) initiated a joint Reclamation Research Program. Three priority areas have been identified:

1) Woody Plant Research

2) Soil Reconstruction

3) Equipment Development.

The Woody Plant Research Program is now underway and test plots for the Soil Reconstruction Research Program were constructed in 1983.

A) SOIL RECONSTRUCTION ON TAILINGS SAND

1. Soil Reconstruction Project - Phase I Literature Review (79-24-OSE)
   R. Johnson, Montreal Engineering Co. Ltd.

This joint OSESG/RRTAC project identified available soil-building materials in the Oil Sands area and proposed several combinations of these materials to form productive soils. Phase I, which was a literature review and analysis of existing information was funded in 1979/80. The review identified treatments for the Test Plot Program which will constitute Phase II of the

Soil Reconstruction Project.

Status: Completed
Results: Report # OSESG/RRTAC 83-1

2. Soil Reconstruction Project:
Phase II Field Trials (83-10-HAR)
H.E. Martens, Hardy Associates (1978) Ltd.

Field trials were established on a 7 ha pad of tailings sand prepared by Syncrude Canada Ltd. on their property north of Ft. McMurray. Various mixtures of peat and clay were incorporated to 20 and 40 cm depths. In 1984 the plots will be planted with tree and shrub species to identify the best soil prescription for a particular forest cover type.

Status: Plot construction completed, Seedlings planted

3. Reinstatement of Biological Activity in Reconstructed Soils
(81-3-PAR, 78-4-PAR)
D. Parkinson, University of Calgary

The nature of micro organism establishment on reconstructed spoils was investigated in a series of field and laboratory studies. Emphasis centered on Fungal Decomposers and Mycorrhizal Fungi and the influence of various amendments (peat, sewage sludge, inorganic fertilizers) on their populations.

Status: Completed
Results: Report # RRTAC 84-4

4. Mycorrhizal Potential in Reconstructed Soils (81-2-PAR)
D. Parkinson, University of Calgary

Mycorrhizal Fungi nearly always enhance tree nutrition. This

project has determined the survival and inoculum potential of Mycorrhizal Fungi in undisturbed and stockpiled peat to be used in oil sand tailing reclamation. Also, Fungal species have been selected for use in Jack Pine seedling inoculation. Their effect on tree growth is being monitored in field trials.

Status: Ongoing

B) REVEGETATION

Revegetation in the Oil Sands will focus on establishing shrubs, commercial and non-commercial tree species and in some areas a grass-legume cover for erosion control. The latter is readily accomplished so the Revegetation Research Program concentrates on establishment of shrubs and trees.

5. Selection of Tree and Shrub Varieties for Oil Sand Reclamation (79-13-DUN)
   S.K. Takyi, P. King, Alberta Forest Service

In 1979 a test site in the oil sands area was planted with varieties of native and exotic tree and shrub species to help select those most suitable for oil sands reclamation.

Status: Ongoing

6. Survey Establishment and Maintenance Procedures (81-4-P/F)
   R. Hermesh, Techman Engineering Ltd.

7. Review of Propagation Methods (81-5-WAT)
   R. Hermesh, Techman Engineering Ltd.

8. Seed Collection for Shrub & Tree Trials (81-6-K/K)
   D.J. Klym, Suncor Inc., P. King, Alberta Forest Service

9. Review of Sampling Methods (81-7-ROW)
M.J. Rowell, Norwest Soils Ltd.

These four Projects were preliminary to establishment of Field Trials in 1983. All were jointly supported by OSESG and RRTAC.

Status: **Completed**

Results: Final Reports: 81-6-K/K, 81-7-ROW
Reports # OSESG/RRTAC 83-5
OSESG/RRTAC 84-1

IV GENERAL

A number of projects will yield results applicable to reclamation problems throughout Alberta. These projects are listed below.

Projects

1. Reclamation Review (78-6-SIM)
H.P. Sims, Alberta Environment

This project will compile information from the international reclamation literature pertinent to Alberta. The Reclamation Review will not only serve as a handbook of reclamation techniques, it will also identify gaps in our reclamation knowledge and point the way for future research. It may be accessed via the Computerized Search Guide/Bibliography and the text "Land Surface Reclamation: A Review of International Literature".

Status: Completed

Results: Reports # RRTAC 82-1- Computer Search Guide and Bibliography

RRTAC 84-1- Land Surface Reclamation:
A Review of International
Literature

2. Reclamation Activities in Alberta (80-15-SIM)
H.P. Sims, Alberta Environment

Reclamation and reclamation research activity in Alberta were surveyed and presented in report form.

Status: Completed
Results: Report # RRTAC 81-2

3. Cross Reference for Reclamation Review (80-13-WAL)
D.G. Walker, David Walker Assoc. Ltd.

This project provided a cross reference of keywords, authors and subjects as part of the Reclamation Review.

Status: Completed
Results: Report # RRTAC 82-1

4. Species Suitability Manual (79-5-W/P)
L.E. Watson, Techman Ltd.

This manual catalogued available information on the many species used as useable in reclamation. This will help Reclamationists design seed mixes which are better adapted to their particular needs.

Status: Completed
Results: Report # RRTAC 80-5 Vol. I Grasses
Vol. II Forbs, Shrubs & Trees

LOCATION OF FIELD PLOTS

PLAINS

1) 79–2–MOR FORESTBURG, HIGHVALE.
2) 82–5–LES FORESTBURG.
3) 82–13–SCH HIGHVALE.
4) 79–26–FUJ BOW CITY.
5) 78–4–PAR CALGARY.
6) 83–4–LAN FORESTBURG

MOUNTAINS & FOOTHILLS

1) 79–1–MAC GRANDE CACHE.
2) 79–16–MIH COALVALLEY, CROWSNEST.
3) 79–17–TAK CADOMIN.
4) 79–18–RUS CADOMIN.
5) 80–11–TAK CADOMIN.
6) 79–23–WEI CADOMIN, GRANDE CACHE.
7) 82–11–Z/T CADOMIN.
8) 82–14–CHO GRANDE CACHE, LUSCAR, CROWSNEST

NORTHEAST OIL SANDS

1) 81–2–PAR MILDRED LAKE.
2) 79–13–DUN MILDRED LAKE.
3) 83–10–HAR MILDRED LAKE

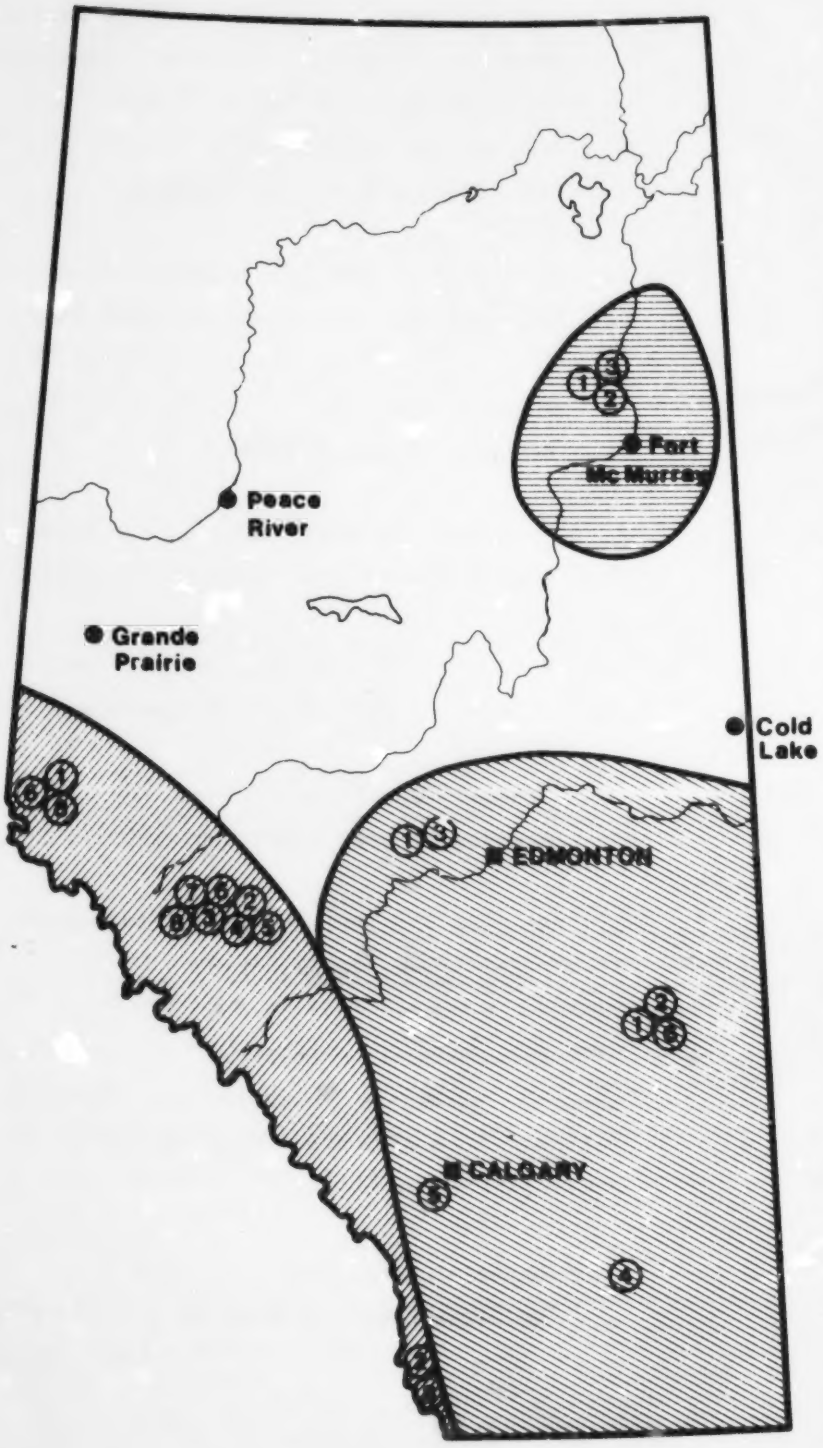

TABLE 1. PRIORITIES & PROGRAM SUMMARY TO DATE, PLAINS AGRICULTURAL LAND

OBJECTIVE: Restoration of Agricultural Capability

PROBLEM AREA	RESEARCH PRIORITIES	PROJECTS	DESCRIPTION	FROM 1 APRIL, 1978 TO 31 MARCH, 1985 RRTAC EXPENDITURES**	INDUSTRY INVOLVEMENT
Groundwater/ Geology	- Effects of Mining on groundwater supplies - Generation of Salts in Spoil - Transport of Salts near the Reclaimed Soil Surface - Subsidence after Reclamation - Effects of underground Ash disposal - Overburden classification	79-2-KOR 79-22-HOD* 79-27-HOD* 80-14-MAR*	The Regions Including and surrounding the Battle River and Highvale Mining areas are being intensively monitored to assess the effects of mining on the Soil, Water and ultimately, the Agricultural Resources. As significant concerns are identified remedial measures are also evaluated. Phase I of the Project is completed. The Long Term effects of subsidence, salinization and soil quality are being monitored.	5,259,481	Joint Management and Project Review through Project Steering Committee, Site Access and information sharing: Alberta Power Ltd. Manalta Coal, Luscar Ltd. and TransAlta Utilities
Soil Reconstruction	- Thickness of Subsoil required above Sodic Spoil - Effects of Slope on lateral salt transport - Reconstruction of Solonetzic Soils - Use of Bottom Ash as Soil Amendment - Effects of different Crops on Thickness Requirements - Changes in Topsoil during stockpiling	82-5-LES 82-13-SCH 79-6-SCH* 79-26-FUJ* 83-4-LAN	Experimental Plots have been constructed on the Battle River and Highvale Mine areas and 1985 will be their fourth and third crop years respectively The Plots will be intensively monitored annually for five crop years each.	873,894	Plot Construction: Joint Management and Project review through Project Steering Committee: Alberta Power Ltd., Luscar Ltd., Manalta Coal and TransAlta Utilities
Fly and Bottom Ash Disposal	- Chemical and Physical Properties of Alberta Fly & Bottom Ashes - Potential for use as Soil Amendment	78-2-MCC* 78-20-MCC* 78-5-P/R* 80-19-MCC*	Ashes from five Alberta Sources were analyzed for both toxicity and Soil Amendment possibilities. This Program is completed and the results are published in Report #RRTAC 81-3.	12,176	Provision of Ash Samples: Alberta Power Ltd., TransAlta Utilities and Saskatchewan Power Ltd.
Pipelines	- Identify the best methods for handling soil materials in pipeline construction in Agricultural land	81-1-HAS*	A Survey was made of Pipelines of various ages on all of our major Agricultural Soil types. Material handling methods were assessed and problem areas identified. Results are published in Report #RRTAC 83-3.	40,120	A member of the pipeline Industry sat on the Project Mgm't. Committee access to construction records route locations and demonstrations
				6,185,671	

* Completed Projects
** 1984/85 Expenditures are estimated

TABLE 2. PRIORITIES AND PROGRAM SUMMARY TO DATE, MOUNTAINS & FOOTHILLS COAL MINING

OBJECTIVE: Restoration of Forestry, Wildlife and Watershed Capabilities

PROBLEM AREA		RESEARCH PRIORITIES	PROJECTS	DESCRIPTION	FROM 1 APRIL, 1978 TO 31 MARCH, 1985 RETAC EXPENDITURES**	INDUSTRY INVOLVEMENT
Landscape Design		Design & Construction of Stable Spoil Dumps	82-14-CHO	Survey of Existing Reclaimed Dumps in Alberta and British Columbia to identify Practical Resloping Strategies	93,702	Site preparation, information sharing
		Water Management	84-12-MON	Identification of settling pond size requirements	25,000	50% funding Coal Association of Canada
Soil Reconstruction		For Commercial Forestry Potential	84-23-PED 84-28-DEM	Literature Review and Evaluation of Seedling Growth in Reforestation Sites and Forest Soil Reconstruction Requirements	24,775	50% funding Coal Association of Canada
		For Erosion Control on Ash Dumps	79-1-MAC	Thickness of Soil required over Coal Ash to support vegetation	14,975 50,371	Plot Construction Smoky River Coal
Revegetation	Herbaceous Cover	Species Selection	79-7-WEI 79-23-WEI 82-12-TOM* 79-5-W/P* 79-18-RUS	Development, assessment and Field Testing of Native Grasses for reclamation. Presentation of known information on Species for Reclamation	572,333	-
		Erosion Control	79-17-TAK 80-11-TAK 78-1-LAR* 82-9-LLO*	Mulches, Binders & Contouring Techniques for erosion control on coal spoil	17,475	-
		Fertilization, Nutrients	82-11-Z/T 78-3-M/P* 79-8-L/R*	Identification of Treatments Important to development of self-sustaining Plant Cover	38,353	-
	Tree & Shrub Cover	Propagation	80-16-KIN* 82-1-K/H*	Propagation of Shrubs for Reclamation	20,181	-
		Establishment	79-16-MIH	Establishment of Tree Seedlings in Grass Cover	0	-
		Wildlife Habitat	84-18-LGL	How to reclaim for Wildlife Habitat	14,772	50% funding Coal Association of Canada
					871,937	

TABLE 3. PRIORITIES & PROGRAM SUMMARY TO DATE, NORTHEAST ALBERTA, GENERAL

OBJECTIVE: Restoration of Forestry, Wildlife Capabilities and Erosion Control

PROBLEM AREA	RESEARCH PRIORITIES	PROJECTS	DESCRIPTION	FROM 1 APRIL, 1978 TO 31 MARCH, 1985 RRTAC EXPENDITURES**	INDUSTRY INVOLVEMENT
Soil Reconstruction on Tailings Sand	Identify Recipes for Reconstructed soils suitable for: - Commercial Forest - Non-Commercial Forest - Erosion Control/ - Wildlife Habitat	78-4-PAR* 79-24-OSE* 81-2-PAR 81-3-PAR* 83-10-HAR	Identification of the chemical and Microbiolical properties of peat, development of mycorrhizal innoculants for Jack Pine and other woody species, identification of amendment level requirements. The earlier studies are largely complete and were fundamental in designing the Oil Sand Soil Reconstruction Plots (83-10-HAR) which were constructed in 1983.	808,864	Joint Project Development, Management, review and 80% funding of 79-24-OSE. Provision of test site for 81-2-PAR, 50% funding 83-10-HAR
Revegetation	Shrub & Tree - Selection - Propagation - Establishment - Management	79-13-DUN 81-4-P/F* 81-5-WAT* 81-6-K/K* 81-7-ROW*	These projects consist of Tree and Shrub selection, Seed collection, development of Propagation Techniques, and Sampling Methods for use on the Soil Reconstruction Plots to be constructed in 1983.	14,499	Project development, Joint/Management, review and 50% Funding of 81-4,5,6, 100% Funding of 81-7 ROW
				823,363	
Equipment Development	For Incorporation of Tailing Sand Amendments (e.g. Peat, Clay)	(No Formal Projects or Contracts were commissioned under this priority. Rather Government and Industry staff have jointly reviewed available equipment and arranged trials under operational conditions. The evaluation is complete).			
GENERAL* **					
Reclamation Review	Document the Findings of Reclamation Research activities and assess implications for Alberta Operations	78-6-SIM* 79-20-WAL* 80-15-SIM* 80-13-WAL*	World wide Reclamation Literature has been reviewed and condensed for presentation in a Report which lists and discusses existing information as pertinent to Reclamation in Alberta. The data base is accessable through The University of Alberta computing system. See Reports #RRTAC 82-1, 81-2 and 84-1.	71,823	
				71,823	
	Total for all RRTAC Programs as of 31 March, 1985			7,952,794	

*** Projects with Province-wide application

RESEARCH PROJECTS 1984-85

Managing Agency (Research Organization Principal Investigator)	Project #	Research Subject	RRTAC Budget (1984-85)
Alberta Energy & Natural Resources Alberta Forest Service			
(Alberta Forest Service S.K. Takyi, P. King)	79-13-DUN	Selection of Woody Plants for Oil Sand Reclamation	0 1/
(Alberta Forest Service P. King)	79-16-MIH	Establishment of Tree and Shrub Seedlings in Erosion Controlling Cover, Coal Valley, Crowsnest	0
(Alberta Forest Service S.K. Takyi)	79-17-TAK	Use of Mat Mulches on Difficult Slopes, Cadomin	0
(Alberta Forest Service R. Islam	79-18-RUS	Evaluation of Native-Agronomic Grass and Legume Mixes, Cadomin	0
(Alberta Forest Service S.K. Takyi)	80-11-TAK	Methods of Establishing Native Grass on Unamended Coal Spoil, Cadomin	0
(Scientific & Engineering Services P.F. Ziemkiewicz/ S.K. Takyi)	82-11-Z/T	Development of Stable Nutrient Cycles on Subalpine Coal Spoil	0
(Coal Mining Research Center R. Chopiuk)	82-14-CHO	Survey of Mountain Waste Dumps and Resloping Operations	41,290

Managing Agency (Research Organization Principal Investigator)	Project #	Research Subject	RRTAC Budget (1984-85)
Alberta Environment Research Management Division			
(Alberta Research Council S.R. Moran)	79-2-MOR	Hydrologic Impacts of Plains Surface Coal Mining, Forestburg, Highvale	755,664
(Alberta Environmental Center, Vegreville R. Hermesh)	79-7-WEI	Development of Native Grasses for Reclamation	0
(Biology Department, University of Calgary D. Parkinson)	81-2-PAR	Mycorrhizal Development in Reconstructed Soils	89,253
(Pedology Consultants Ltd. L. Leskiw)	82-5-LES	Battle River Soil Reconstruction Project	140,000 3/
(Monenco Consultants Ltd. L.A. Panek	82-13-SCH	Highvale Soil Reconstruction Project	126,429 3/
(Hardy Associates (1978) Ltd. H.E. Martens)	83-10-HAR	Oilsands Tailings Soil Reconstruction Project	75,000
(Alberta Environment S. Landsburg)	83-4-LAN	Amendment of Orphaned Mine Spoils with Bottom Ash	13,408
(Monenco Consultants Ltd. A. Somani)	84-12-MON	Water Mangement in Mountains & Foothills Mines	25,000 4/
(LGL Ltd. J. Green)	84-18-LGL	Reclamation for Wildlife Habitat in the Mountains & Foothills	14,722 4/
(Pedocan Land Evaluation Ltd. L. Knapik)	84-23-PED	Soil Reconstruction in the Mountain & Foothills Mining	24,775 4/

Managing Agency (Research Organization Principal Investigator)	Project #	Research Subject	RRTAC Budget (1984-85)
Alberta Environment Research Management Division			
(W.R. Dempster & Associates Ltd. W.R. Dempster)	84-28-DEM	Growth Performance of Commercial Tree Species in Reclamation	14,975 4/
		TOTAL	1,320,516

1/ Projects requiring no RRTAC Budget are fully funded by the Managing Agency

2/ Cooperatively funded with Alberta Power Ltd., Luscar Ltd., Manalta Coal Ltd., and TransAlta Utilities Ltd.

3/ Cooperatively funded with Syncrude Canada Ltd., Suncor Inc. and the Oilsands Environmental Study Group

4/ Cooperatively funded with The Coal Association of Canada

LAND CONSERVATION

AND

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Mr. J.E. Benson	Alberta Energy & Natural Resources, Alberta Forest Service, Deputy Chairman
Mr. M.G. Turnbull	Alberta Energy & Natural Resources Public Lands Division, Deputy Chairman

RECLAMATION RESEARCH

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